CLAIMS

What is claimed is:

1. A tunneling sensor with linear force rebalance, said tunneling sensor comprising:

a plate electrode, said plate electrode being movable about an axis of rotation, said plate electrode having a first end and a second end separated by said axis of rotation, said plate electrode being unbalanced about said axis of rotation, said plate electrode having a tunnel-effect contact formed thereon;

a pair of torque rebalance bridge electrodes, a first torque rebalance bridge electrode in said pair being disposed proximate said first end of said plate electrode, a second torque rebalance bridge electrode in said pair being disposed proximate said second end of said plate electrode;

a tunnel-effect tip, said tunnel-effect tip being disposed proximate said tunnel-effect contact;

means for electrically biasing said tunnel-effect contact and said tunnel-effect tip;

means for sensing a tunnel current between said tunnel-effect contact and said tunnel-effect tip; and

feedback means for processing said tunnel current and electrically exciting said pair of torque rebalance bridge electrodes with complementary rebalance voltages derived from said processed tunnel current so as to generate an electrostatic

WEINGARTEN, SCHURGIN,
GAGNEBIN & HAYES
TEL (617) 542-2290
FAX (617) 451-0313

rebalance force against said plate electrode that is linearly related to an imbalance force against said plate electrode which is created by an acceleration thereof.

2. The tunneling sensor as defined in claim 1, further comprising a pendulous mass, said pendulous mass being formed on said plate electrode, said pendulous mass creating said unbalance of said plate electrode.

3. The tunneling sensor as defined in claim 1, further comprising a pendulous mass, said pendulous mass being formed on said plate electrode, said pendulous mass contributing to said unbalance of said plate electrode.

4. The tunneling sensor as defined in claim 1, wherein said tunnel-effect contact is gold.

5. The tunneling sensor as defined in claim 1, wherein said plate electrode is boron diffused silicon.

6. The tunneling sensor as defined in claim 1, wherein said pair of torque rebalance bridge electrodes are symmetrically spaced and located equidistant from said axis of rotation.

WEINGARTEN, SCHURGIN,
GAGNEBIN & HAYES
TEL (617) 542-2290
FAX (617) 451-0313

7. The tunneling sensor as defined in claim 1, wherein said pair of torque rebalance bridge electrodes have perforations formed therein so as to reduce a damping spring coefficient thereof.

8. The tunneling sensor as defined in claim 1, wherein said pair of torque rebalance bridge electrodes are gold.

9. The tunneling sensor as defined in claim 1, wherein said tunnel-effect tip is disposed proximate said tunnel-effect contact so as to be in line with a rotational path that said tunnel-effect contact takes when said plate electrode is moved about said axis of rotation.

10. The tunneling sensor as defined in claim 1, wherein said tunnel-effect tip is gold.

11. The tunneling sensor as defined in claim 1, wherein said means for electrically biasing said tunnel-effect contact and said tunnel-effect tip comprises grounding said tunnel-effect contact and applying a bias voltage to said tunnel-effect tip.

12. The tunneling sensor as defined in claim 1, wherein said means for sensing a tunnel current between said tunnel-effect contact and said tunnel-effect tip essentially comprises electronic sensing circuitry.

WEINGARTEN, SCHURGIN,
GAGNEBIN & HAYES
TEL (617) 542-2290
FAX (617) 451-0313

13. The tunneling sensor as defined in claim 1, wherein said feedback means comprises means for providing an output torque voltage that is linearly related to said acceleration.

14. The tunneling sensor as defined in claim 1, wherein said complementary rebalance voltages comprise a constant bias voltage component and a torque voltage component, wherein said constant bias voltage component is added and subtracted from said torque voltage component so as to produce said complementary rebalance voltages.

15. The tunneling sensor as defined in claim 1, wherein said feedback means comprises means for converting said tunnel current into a representative voltage.

16. The tunneling sensor as defined in claim 1, wherein said feedback means comprises logarithmic means for linearizing the exponential dependence of said tunnel current on the displacement between said tunnel-effect contact and said tunnel-effect tip.

17. The tunneling sensor as defined in claim 1, wherein said feedback means comprises reference means corresponding to a desired quiescent point for said tunnel current and the displacement between said tunnel-effect contact and said tunnel-effect tip.

WEINGARTEN, SCHURGIN,
GAGNEBIN & HAYES
TEL (617) 542-2290
FAX (617) 451-0313

18. A method for fabricating a tunneling sensor with linear force rebalance, said method comprising the steps of:

providing a substrate having an insulator formed thereon;

patterning said insulator and diffusing said substrate so as to form a plate electrode therein;

depositing a tunnel-effect contact on said plate electrode;

electroplating a pair of bridge electrodes and a tunnel-effect tip on said insulator so as to be disposed proximate said plate electrode; and

etching selected areas of said substrate so as to free said plate electrode from said substrate except for where at least two torsion flexures are formed between said plate electrode and said substrate thus forming an axis of rotation about which said plate electrode is movable, said plate electrode thereby having a first end and a second end separated by said axis of rotation, a first bridge electrode in said pair being disposed proximate said first end of said plate electrode, a second bridge electrode in said pair being disposed proximate said second end of said plate electrode, said tunnel-effect tip being disposed proximate said tunnel-effect contact so as to be in line with a rotational path that said tunnel-effect contact takes when said plate electrode is moved about said axis of rotation.

WEINGARTEN, SCHURGIN,
GAGNEBIN & HAYES
TEL (617) 542-2290
FAX (617) 451-0313

18

~~19~~ 2. The method as defined in claim ~~18~~ 1, wherein said step of electroplating said pair of bridge electrodes comprises electroplating said pair of bridge electrodes so as to be symmetrically spaced and located equidistant from said axis of rotation.

~~20~~ 3. The method as defined in claim ~~18~~ 1, further comprising the step of electroplating said pair of bridge electrodes so as to have perforations formed therein.

~~21~~ 4. The method as defined in claim ~~18~~ 1, further comprising the steps of:

depositing a sacrificial (spacer) layer on selected areas of said substrate, said plate electrode, and said insulator; and

etching said sacrificial (spacer) layer so that said pair of bridge electrodes span said plate electrode and a gap is formed between said tunnel-effect tip and said tunnel-effect contact.

~~22~~ 5. The method as defined in claim ~~21~~ 4, further comprising the steps of:

depositing a thin metal (seed) layer on selected areas of said substrate, said plate electrode, said insulator, and said sacrificial (spacer) layer; and

etching said thin metal (seed) layer along with said sacrificial (spacer) layer.

WEINGARTEN, SCHURGIN,
GAGNEBIN & HAYES
TEL (617) 542-2290
FAX (617) 451-0313

~~23~~ 4. The method as defined in claim ~~18~~ 1, further comprising the step of forming a pendulous mass on one end of said plate electrode.

~~24~~ 7. The method as defined in claim ~~18~~ 1, wherein said step of diffusing said substrate comprises performing a boron diffusion using a solid source boron diffusion at a temperature between 1100°C and 1200°C.

116728

WEINGARTEN, SCHURGIN,
GAGNEBIN & HAYES
TEL (617) 542-2290
FAX (617) 451-0313

20